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The role of variation as a determinant of infant categorical responding was investigated in three studies of infants 7 to 7 1/2 months of age. Sixty-three infants, divided into groups of 21 each, were habituated to color slide poses of either one, two, or six different adult female faces. Their responses to a novel pose of a familiar face and a novel pose of a novel face were observed. In every condition, infants generalized habituation to the familiar face, but only infants shown six different faces during habituation responded categorically (that is, generalized habituation to the novel face). Infants shown poses of one, two, and even three different faces during habituation dishabituated to the novel face. They did so even when offered only as many presentations of each particular face during familiarization as were the infants shown poses of six different faces. Thus, infants exposed to limited variation seemed to respond on the basis of memories for the specific few exemplars they had seen, rather than on the basis of an abstracted representation of their shared attributes. It was suggested that infant categorical responding may betoken not an active search for invariants but a passive failure of memory for details, which occurs only when the details are too numerous to keep track of individually. (Author/RH)

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The role of variation in infant categorization

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Running head: THE ROLE OF VARIATION IN INFANT CATEGORIZATION

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Abstract

The role of variation as a determinant of infant categorical responding was investigated in three studies. Infants 7 to 7 1/2 months old were shown poses of either one, two, three, or six different female faces, and their responses to a novel pose of a familiar face and a novel pose of a novel face were observed. Infants in every condition generalized habituation to the familiar face, but only infants shown six different faces during habituation responded categorically, that is, generalized habituation to the novel face. Infants shown poses of one, two, and even three different faces during habituation dishabituated to the novel face. They did so even when offered only as many presentations of each particular face during familiarization as were the infants shown poses of six different faces. Thus, infants exposed to limited variation seemed to respond on the basis of memories for the specific few exemplars they had seen, rather than on the basis of an abstracted representation of their shared attributes. It is suggested that infant categorical responding may betoken not an active search for invariants, but a passive failure of memory for details, which occurs only when the details are too numerous to keep track of individually.

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The role of variation in infant categorization

Recent research has provided ample evidence that infants are capable of responding categorically, that is, of treating as equivalent stimuli which are discriminably different. For preverbal infants, this ability is usually demonstrated with the multiple habituation paradigm or an adaptation of the paired- preference paradigm. In these procedures, infant subjects are first habituated or familiarized to a series of related stimuli, rather than to a single, repeated stimulus. They are then presented, either successively or simultaneously, with another of the related stimuli which they have not yet seen and with an unrelated stimulus. Continued habituation to the "novel" related stimulus and dishabituation to the unrelated one or preference for the unrelated one over the novel related stimulus is taken as evidence for categorical responding. It is inferred that the infants noted the similarity of the familiarization stimuli and responded on the basis of that shared property rather than the specific instances they had seen. These procedures have been used to show that infants can learn or respond to categories such as human faces (Cornell, 1974; Fagan, 1976; Cohen & Strauss, 1979), schematic faces (Sherman, 1983; Strauss, 1979), stuffed toy animals (Cohen & Caputo, 1978), airplanes, cars, dogs, and women (Reznick & Kagan, 1979), shapes (Ruff,1978), and others.

Although knowledge pertaining to a category may in some cases arise from extensive experience with a single exemplar (see Carey, 1977; Nelson, 1974), categorical responding by infants is clearly promoted by what Harris (1983) refers to as "variegated experience." The procedures used to demonstrate categorical responding indeed illustrate the role of variation, but its effect has been studied more directly, too. Fagan (1976) presented

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a single instance of a male face to one group of 7-month-olds and two different male faces to another group during familiarization. Only the infants familiarized with two male faces exhibited categorical responding; on a simultaneous-choice test, they preferred a female face to a novel male face. The infants presented with just one male face during familiarization paid equal amounts of attention to the two test stimuli. Both Ruff (1978) and Reznick and Kagan (1983) found that infants exposed to within-trial variation during familiarization later showed stronger categorical responding than infants exposed to between-trial variation. That is, simultaneous presentation of two different category members during familiarization resulted in greater test preferences for a non-member over a novel member than did successive presentation of different category members. Cohen and Strauss (1979) noted that the nature of the variation displayed during familiarization seems to determine at what level of generality infants will respond on subsequent recognition tests. They found that infants repeatedly shown a single pose of the same female face dishabituated to both a new pose of that same face and a new pose of a novel face, while infants shown multiple poses of a single female face dishabituated only to the new pose of the novel face. Infants shown multiple poses of six different female faces did not dishabituate to either test stimulus. In other words, infants shown a single stimulus did not categorically respond at all, infants shown a variety of poses of one female face categorically responded to a new pose of it, and infants shown a variety of poses of a variety of female faces categorically responded to both a new pose of a familiar face and a new pose of a novel face.

The idea that exposure to multiple exemplars somehow leads to responding at a level of abstraction that encompasses the several items is

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also consistent with some observations of young children's object labeling. In a study by Callanan (1985), 3- to 5-year-olds for whom two different exemplars of a superordinate category were given a nonsense label seemed to interpret the term as a superordinate label, whereas children for whom only one exemplar was given the nonsense label interpreted it as a subordinate or basic category label. In informal observations of her daughter, the first author noted a similar pattern; the child generalized nonsense words incorporated into the language spoken to her only if the words had been used to label more than one particular object or event. In cases in which a nonsense word had been used with only one specific referent, it was not generalized to similar objects or events, but instead seemed to be interpreted as a proper name. Thus, in lexical acquisition, the application of a label to two or more different referents evidently informs the listener that the term is a general one that makes reference to something(s) invariant over the several usages.

Some investigators have supposed that variation may play a similarly didactic role in multiple habituation and preference paradigms, thereby accounting for its relationship to categorical responding. Cohen and Caputo (1978) suggested that exposure to a number of different items in a sense "instructs" the infant to focus on what those items have in common. This focusing may be accomplished in some cases by "averaging" the different values seen for features of the familiarization stimuli (Strauss, 1979) and in other cases by "counting" the different values of the features to assess which were most frequent (Sherman, 1983). With either averaging or counting, the infant is thought to be actively constructing a summary representation or "prototype," against which incoming stimuli are then compared.

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It is not clear, though, that exposure to a small number of different exemplars leads to responding at the encompassing general level (i.e., to categorical responding) in the infant looking paradigms, as it does in the word-learning situation. As previously noted, Fagan (1976) did familiarize one group of infants with just two different male faces and reported that these infants later preferred a female face over a novel male face. This preference, though, does not necessarily indicate that the infants were responding at the level of "male faces;" it just indicates that the female face was perceived as relatively more novel than the male face. If the novel male face had been presented simultaneously with one of the familiar male faces, the infants might very well have preferred it, rather than treating the familiar and novel category members equivalently. Indeed, both Fagan (1978) and Rose, Gottfried, Melloy-Carminar, and Bridger (1982) found that the presence of a "contrast" stimulus during familiarization enhanced performance on later recognition tests which paired the familiarization stimulus with a third item. These findings suggest that limited variation in infant looking paradigms may somehow facilitate the encoding of all the features displayed, including both those which distinguish within-category items and those which distinguish across-category items. Such enhanced attention to both similarities and differences is distinct from categorical responding, in which the differences among within-category items should be ignored.

In the research reported below, we investigated how the amount of variation encountered interacts with the occurrence of categorical responding in the multiple habituation paradigm. In three studies similar to that conducted by Cohen and Strauss (1979), infants were exposed to different numbers of exemplars of a category, and then their responses to a

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familiar exemplar, a novel exemplar, and an out-of-category item were observed. The general goal of the inquiry was to clarify the basis and nature of infant categorical responding, as compared to other classificatory behaviors. The purpose of Study 1 was to replicate Cohen and Strauss (1979) and furthermore to determine whether exposure to limited variation leads to categorical responding or not. The purposes of Studies 2 and 3 were to resolve issues raised by the results of Study 1.

Study 1

In order to investigate the role of variation as a determinant of categorical responding, the behavior of infants in three experimental conditions was examined in Study 1. Infants in Condition I were habituated to different poses of a single female face, infants in Condition II were habituated to different poses of two different faces, and infants in Condition III were habituated to different poses of six different faces. Following habituation, infants in all three conditions were shown test slides of a new pose of a familiar face and a new pose of a novel face. Conditions I and III were very similar to two of the conditions in the Cohen and Strauss (1979) study, and infants in these conditions were expected to respond accordingly. Thus, infants in Condition I were expected to generalize habituation to the familiar test stimulus but to dishabituate to the novel test stimulus. Infants in Condition III, on the other hand, were expected to generalize habituation to the novel test stimulus as well as to the familiar test stimulus, that is, they were expected to respond categorically. The question of interest in Study 1 was whether or not infants in Condition II would likewise respond categorically. If exposure to distinct exemplars indeed directs infants to

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attend to the superordinate level that encompasses the several items, that is, to seek the lowest common denominator as it were, then infants in Condition II would be expected to respond like those in Condition III and generalize habituation to both test stimuli.

Method

Subjects. The final sample consisted of 63 infants, each between 7 and 7 1/2 months old (M = 220 days). Twenty-one infants were assigned to each of the three experimental conditions; there were 11 females and 10 males in Conditions I and II, and 10 females and 11 males in Condition III. An additional 24 infants were tested but could not be included in the final sample. Nine of these were excluded because they became fussy or distracted during the procedure, eight were excluded because they failed to reach the habituation criterion, and seven were excluded due to experimenter error or equipment failure. The exclusion rates for the three conditions were not remarkably different. All participants were recruited by mail solicitation based on public birth records, and all were reported to be full-term and healthy by their parents.

Stimuli and apparatus. The stimuli were color slides of the faces of seven young adult women. Twelve different poses of each woman were included among the habituation stimuli. In each pose, the woman was shown in one of four 3/4 profiles--looking to the upper left, upper right, lower left, or lower right--and displaying one of three facial expressions--a smile, a frown, or surprise. The test stimuli consisted of an additional pose of each woman, looking full-forward and displaying a neutral facial expression. A 24 x 24 black-and-white checkerboard pattern was also used at the beginning and end of the procedure.

The slides were rear-projected onto a 69 x 94 cm Polacoat screen which

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was mounted on a table and enclosed at the sides by grey Triwall panels. The projected poses measured 23 x 23 cm and appeared slightly to the left of the screen's center. At the bottom of the screen were two small peepholes, through which observers stationed behind the screen watched the infant and recorded fixation times by means of pushbuttons connected to a microprocessor.

Procedure. Each infant was seated on a parent's lap facing the projection screen and about 65 cm away from it. The parent was instructed not to direct the infant's attention in any way throughout the procedure. All infants were first shown a black-and-white checkerboard pattern to uuorient them toward the screen and then were shown a series of habituation slides. Infants in Condition I were shown up to 12 different 3/4 poses of a single woman's face. Infants in Condition II were also shown up to 12 different 3/4 poses, but these included six different poses of each of two women's faces. Finally, infants in Condition III were shown up to 12 different 3/4 poses which included two different poses of each of six women's faces. For infants in Condition I, the order in which the 12 poses were presented was random. For infants in Conditions II and III, the orders of the 12 poses were yoked to those used for infants in Condition I, though which woman was displayed in which pose was randomly determined. Within each condition, slides of each of the seven women served equally often among the habituation stimuli.

Appropriate habituation slides were shown to each infant until the average duration of looking for three successive stimuli reached a criterion of less than 50% of the average duration of looking for the first three habituation stimuli. If an infant had not reached criterion after all 12 poses had been presented, the poses were repeated in the same order.

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If an infant had not reached criterion after the set of poses had been presented twice, he or she was excluded from the sample for failure to habituate. Once the habituation criterion had been reached, each infant was shown three further slides from the habituation series (the "posthabituation" trials) and then two test slides. The test slides were the full-forward pose of a woman who had been seen in one or more 3/4 poses during habituation (the "familiar" test stimulus) and the full-forward pose of a woman who had not been seen during habituation (the "novel" test stimulus). Within each condition, the order of the familiar and novel test stimuli was counterbalanced and slides of each of the seven women served equally often as the familiar and the novel stimulus. After the test stimuli, all infants were shown the black-and-white checkerboard again. The final checkerboard served as a "nonmember" of the category of female faces, so that dishabituation could be demonstrated (and general fatigue ruled out) for the groups of infants that might generalize habituation (respond categorically) to the novel female face.

During all phases of the procedure, the duration of time each slide was projected was infant-controlled. A trial began when the infant had looked at the slide for 1 second and ended when the infant looked away for 2 consecutive seconds. The total duration of looking at the slide during each trial was recorded by an observer watching the infant's eyes from behind the screen. The observer was unaware of the order of the test stimuli for each infant. For 15 infants, 5 from each condition, a second observer also scored looking time. Interobserver reliability was extremely high; the Pearson product-moment correlation between looking times recorded by two observers was .99.

Results and discussion

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All duration of looking scores were converted to common logarithms in order to reduce the variance and normalize the distributions. A conditions x trials analysis of variance performed on the mean log looking times to the first three habituation trials and the three posthabituation trials yielded a significant trials effect (F (1,68) = 131.66, p < .001). Over all conditions, the infants looked longer on the first three habituation trials (M = 1.07) than on the three posthabituation trials (M = .68), indicating that they did indeed habituate to the face stimuli. There was no conditions effect or interaction, however, nor was there a difference among infants in the three conditions in the mean number of trials to reach criterion (M = 8.38). Thus, infants in the different conditions looked at the familiarization stimuli and habituated to them equivalently.

To assess the categorization performance of the infants in each condition, the log looking times for each of the test trials were compared to the log looking times for the last posthabituation trial with an a priori one-tailed t test. The outcomes of these comparisons as well as the results for the three trials involved for each condition are displayed in Table 1. As the table shows, infants in each condition generalized habituation to a new pose of a familiar face; that is, they did not look significantly longer on the familiar test trial than on the last posthabituation trial. Infants in Condition III also generalized habituation to a new pose of a new face; they did not look significantly longer on the novel test trial than on the last posthabituation trial. General fatigue was not responsible for this failure to respond to the novel test stimulus, though. The infants in Condition III looked at the final checkerboard (M = .95) at least as long as at the initial

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checkerboard (M = .84) and significantly longer than at the last posthabituation trial (M = .57), t (20) = 4.46, $p < .001$. Thus infants in Condition III evidenced categorical responding, as they were expected to do. Infants in Condition I also behaved as was predicted. They did not evidence categorical responding, but instead dishabituated to the new face; they looked significantly longer on the novel test trial than on the last posthabituation trial. Finally, infants in the condition of particular interest, Condition II, also dishabituated to the new face. Like the infants in Condition I and unlike those in Condition III, they looked significantly longer on the novel test trial than on the last posthabituation trial. Thus they did not evidence categorical responding.

Insert Table 1 about here

The results of Study 1 first of all confirm the reports by Fagan (1976) and Cohen and Strauss (1979) that 7-month-old infants can recognize a familiar face in a novel pose. Infants in both Conditions I and II evidenced this ability by generalizing habituation to the test pose of a familiar face while dishabituating to the test pose of a novel face. The results for Conditions I and III also replicate the categorization findings of Cohen and Strauss (1979). Infants shown multiple poses of a single face seemed to respond on the basis of a category which included any pose of that particular face, because they generalized habituation to a new pose of that face but dishabituated to a new pose of a novel face. Infants shown multiple poses of six different faces seemed to respond on the basis of a higher-level category which included any pose of any female face, because they generalized habituation to a new pose of a familiar face and to one of

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a novel face, yet they dishabituated to a nonface stimulus. As Cohen and Strauss (1979) concluded, the level of abstraction of the responding was related to the nature of the variation among the stimuli presented.

However, the results for Condition II in this study indicate that exposure to variation in and of itself does not direct infants to respond at the level of the invariant information presented. Infants shown multiple poses of two different faces did not respond on the basis of the higher-level category instantiated, that is, of female faces, even though some variation within this category was present. Although they generalized habituation to a new pose of one of the two familiar faces, they dishabituated to a new pose of a novel face. Thus infants exposed to two exemplars of a category responded on the basis of those particular exemplars rather than on the basis of their common attributes. Categorical responding in the multiple habituation paradigm is evidently determined by something other than the simple presence of variation.

To identify what might then underlie categorical responding, we considered the experience of the infants who did respond categorically in Study I, namely, the infants in Condition III, in comparison to the experience of infants who did not respond categorically, namely, the infants in Conditions I and II. Two differences between these experiences stand out; the infants in Condition III were exposed to a greater number of exemplars and also to fewer repetitions of each given exemplar than the infants in Conditions I and II. Either of these factors, or both, may have been responsible for the categorical responding of the infants in Condition III, in contrast to the responses of the infants in the other conditions. In Studies 2 and 3, the variety of exemplars and the frequency with which each exemplar is seen were studied separately as possible determinants of

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categorical responding.

Study 2

In Study 2, the effect on categorical responding of the number of different exemplars provided was examined, while the frequency with which each exemplar was presented was held constant. Infants were habituated to different 3/4 poses of three different female faces, one more than the number of faces shown to infants in Condition II of Study 1; however, they were exposed to each of the three faces as many times as the Condition II infants had been exposed to each of the two faces involved in their procedure. We also attempted to habituate some additional infants to poses of four different faces with the same number of exposures of each as the Condition II infants had been shown. However, it became apparent that infants would not tolerate the number of habituation trials entailed in this manipulation, so the condition with four exemplars could not be included in Study 2. It was predicted that in contrast to the behavior of the infants shown two exemplars in Study 1, the infants in Study 2 would respond categorically, because their habituation experience included a greater variety of exemplars.

Method

Subjects. Twenty-one healthy, full-term infants (10 females and 11 males), each between 7 and 7 1/2 months old (M = 219 days), served as subjects for Study 2. Four additional infants were tested but were excluded from the final sample because they became fussy during the procedure, and one additional infant was excluded because a sibling distracted him during the procedure.

Stimuli, apparatus, and procedure. The stimuli, apparatus, and procedure for Study 2 were identical to those for Study 1 except for the

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number of exemplars presented and the criteria to be met before moving on to the test trials. The habituation stimuli for each infant in Study 2 included five different poses of each of three women's faces. Among these 15 stimuli, each of the 12 different poses described for Study 1 (4 orientations x 3 facial expressions) was represented at least once by one or another of the three women. Within Study 2, slides of each of the seven women served equally often among the habituation stimuli.

Habituation slides were shown to each infant until the criterion for habituation described for Study 1 had been reached and three "posthabituation" trials had been presented. However, if at this point the infant had not seen each of the three faces in five different poses, further slides from the habituation series were shown until this criterion had also been met. Thus, each infant saw at least 15 slides of faces before the test slides were presented, even if he or she reached the habituation criterion in fewer than 12 trials. This difference in procedure was incorporated so that the infants in Study 2, exposed to three different faces, would nevertheless see each face as frequently as infants in Condition II of Study 1 had seen each of two faces. (Those infants saw an average of 11.3 slides of faces, thus generally 5 of one face and 6 of the other, before the test slides were presented.) When each infant in Study 2 had met both the habituation criterion and the criterion of five exposures to each face, two test slides showing full-forward poses of appropriate faces were presented as in Study 1. The order of the familiar and novel test stimuli was counterbalanced and slides of each of the seven women served equally often as the familiar and novel test stimulus.

Results and discussion

All duration of looking scores were again converted to common

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logarithms to reduce the variance and normalize the distributions. A one-way analysis of variance showed that the infants in Study 2 looked longer on the first three habituation trials (M = .99) than on the three trials immediately prior to the tests (M = .59), F (1, 28) = 101.16, p < .001. Thus, as had the infants in Study 1, the infants in Study 2 indeed habituated to the face stimuli. Although the infants were each presented with at least 15 habituation stimuli, the mean number of trials to reach the habituation criterion was 9.9. This number is not significantly different from the mean number of trials to criterion for the infants in Study 1.

To assess the categorization performance of the infants in Study 2, the log looking times for each of the test trials were compared to the log looking times for the trial immediately prior to the tests with an a priori one-tailed t test. The outcomes of these comparisons and the results for the three trials are shown in Table 1. Contrary to our expectations, the infants did not evidence categorical responding. Although they did generalize habituation to a new pose of a familiar face, they did not generalize habituation to a new pose of a novel face. Instead, they looked significantly longer on the novel test trial (but not on the familiar test trial) than on the last trial of the habituation phase.

We also examined the infants' responses to the final checkerboard pattern, reasoning that they might provide evidence that the infants had abstracted some invariant information from the three exemplars even though they did not respond to the novel face categorically (i.e., as if it were familiar). The final checkerboard had been included in the design primarily as a control to rule out fatigue on the part of groups which did generalize habituation to the novel face (as for Condition III of Study 1,

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above). Nevertheless, it represented an out-of-category stimulus for all infants, and one might predict that infants who showed recovery to a novel category member should show even stronger recovery to the checkerboard, if they had abstracted some category knowledge during familiarization. Hence, for the infants in Study 2 and also for those in Condition II of Study 1, we compared the log looking times for the final checkerboard to the log looking times for the novel test trial with a one-tailed *t*-test. The infants in Condition II of Study 1 did not look longer at the final checkerboard (M = .98) than at the novel test trial (M = .96). The infants in Study 2, however, looked marginally longer at the final checkerboard (M = 1.04) than at the novel test trial (M = .87), $t(28) = 1.34$, $.05 < p < .10$.

The results of Study 2 essentially replicate those of Condition II in Study 1. They indicate that categorical responding is not evoked by exposure to a small number of exemplars, at least not when each of them has been encountered repeatedly. Infants shown multiple poses of three different faces did not respond on the basis of female faces in general, but rather responded on the basis of the specific instances they had seen. They generalized habituation to a new pose of one of the three familiar faces, but dishabituated to a new pose of a novel face. Although they clearly distinguished the novel face from the habituation faces, the infants may also have perceived it as familiar in some respects. Their dishabituation to the novel face was somewhat less vigorous than their dishabituation to an out-of-category item, the checkerboard. Thus, exposure to limited variation during familiarization may have resulted in sensitivity to both similarities and differences among stimuli. It did not lead infants to respond at the level of the abstract category encompassing

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the several items, though. Evidently, the categorical responding of the infants shown six exemplars in Study 1 was determined by the even greater (than three exemplars) variety they experienced or by the fact that each exemplar was encountered only once or twice. The latter possibility was examined in Study 3.

Study 3

In Study 3, the effect on categorical responding of the number of exposures of each offered exemplar was examined, with the number of different exemplars presented held constant. Infants in Study 3 were shown 3/4 poses of three different female faces, but were provided just two presentations of each face. Thus their familiarization experience was similar in one respect--the number of different exemplars seen--to that of the infants in Study 2, who did not evidence categorical responding, and it was similar in another respect--the number of exposures to each exemplar--to that of the infants in Condition III of Study 1, who did evidence categorical responding. The behavior of the infants in Study 3 would therefore implicate one or the other of these factors as the determinant of the categorical responding observed in Condition III of Study 1.

Method

Subjects. Eighteen healthy, full-term infants (9 females and 9 males), each between 7 and 7 1/2 months old (M = 217 days), served as subjects in Study 3. Two other infants were tested but excluded from the final sample, one because the equipment failed during the procedure and the other because of experimenter error. Three of the 18 subjects contributed data only for Block 1 (see below) of Study 3; two of them became fussy during the second part of the procedure, and the equipment failed during

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the second part of the procedure for the third.

Stimuli and apparatus. The stimuli and apparatus were similar to those used in Studies 1 and 2. In Study 3, habituation and test slides of just six of the seven women from the prior studies were used. Three additional test slides were used in the second half of the procedure. These showed the faces of three young adult males; the slides were in all other respects (size, brightness, pose, etc.) similar to the test slides of the female faces.

Procedure. The procedure differed in certain respects from that used in Studies 1 and 2. For each infant, slides of three of the women were designated as familiar and slides of the other three women were designated as novel. Within Study 3, slides of each of the six women were designated as familiar and novel equally often. Following presentation of the black-and-white checkerboard, each infant was shown two triplets of habituation slides. Each triplet contained one 3/4 pose of each of the females designated as familiar for that infant. The six poses shown in the two triplets were all different, and the order of the three familiar females differed in the two triplets. After these six habituation slides had been shown, two test slides were presented, regardless of whether the infant's looking times had declined over the familiarization trials or not. The test slides were the full-forward pose of one of the familiar women and the full-forward pose of one of the novel women. The presentation of these eight slides--six habituation stimuli and two test stimuli--constituted Block 1 for infants in Study 3.

Immediately following Block 1, each infant was presented a second block of eight slides. These consisted of two more triplets of habituation sides of the familiar women, a test slide of a familiar woman other than the

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one shown on the familiar test of Block 1, and a test slide of a novel woman other than the one shown on the novel test of Block 1. It seemed possible that the infants would not look differentially to the familiar and novel test stimuli on Block 1, either because they were still highly interested in all the slides (i. e., they would look for relatively long times at both test slides) or because they were responding categorically (i. e., they would look for relatively short times at both test slides). Block 2 was included in the procedure to determine whether the infants would look differentially to a familiar face and a novel face after additional familiarization presentations, even if they did not do so after the first six. Within both the first and second blocks of the procedure, the order of the familiar and novel test stimuli was counterbalanced and slides of each of the six women served equally often as familiar and novel test stimuli.

Finally, immediately following Block 2, two further slides were shown to each infant. The first of these was one of the three slides of a male face in the full-forward pose. In Study 2, the infants had dishabituated somewhat more vigorously to the final checkerboard than to the novel female face, suggesting that they may have perceived the novel face as familiar in some respects, even though they did not respond to it categorically. The male face was included in Study 3 so that this sort of effect might be explored with a more appropriate out-of-category stimulus. It was always shown after the familiar and novel female test stimuli of Block 2 so that the responses to those would be comparable to the test responses of Block 1 and of Studies 1 and 2. Following the male test slide, the black-and-white checkerboard was again presented. The checkerboard was included as a control to check for fatigue, in case the infants did not dishabituate to

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any of the test stimuli.

During all phases of the procedure, the onset and offset of each trial was infant-controlled as in the other studies. The procedure for recording looking during each trial was also the same as in the other studies.

Results and discussion

As in Studies 1 and 2, all duration of looking scores were again converted to common logarithms to reduce the variance and normalize the distributions. A one-way analysis of variance showed that the infants in Study 3 looked longer on the first triplet of familiarization trials (M = 1.84) than on the second triplet of familiarization trials (M = .82), $F(1, 17) = 12.48$, $p < .005$. Thus, although only 5 of the 18 subjects had reached the criterion of habituation used in Studies 1 and 2, the infants in Study 3 had begun to lose interest in the habituation stimuli by the time of the first tests. All but 1 of the 15 infants who completed Block 2 had reached the criterion of habituation used in the other studies by the time of the second tests.

To assess the categorization performance of the infants on Block 1, the log looking times for each of the Block 1 test trials were compared to the log looking times for the familiarization trial immediately prior to the tests with an a priori one-tailed t test. The outcomes of these comparisons and the results for the three trials are shown in Table 1. As the table shows, the infants exhibited enhanced attention to the novel test stimulus; they looked significantly longer on the novel test trial than on the familiarization trial immediately prior to the tests. They did not similarly exhibit enhanced attention to the familiar test stimulus, though.

Similar comparisons were made between the log looking times for the Block 2 tests and the log looking times for the familiarization trial

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immediately before them. The outcomes of these comparisons and the results for Block 2 are also shown in Table 1. As in Block 1, the infants looked significantly longer on the novel test trial, but not on the familiar test trial, as compared to on the familiarization trial immediately prior to the tests. The infants also looked significantly longer on the male test trial (M = .93) than on the last familiarization trial (M = .63), $t(14) = 2.86$, $p < .01$. However, they did not look any longer on the male test trial than on the novel (female) test trial.

The results of Study 3 confirm the finding of Study 2 that exposure to as many as three exemplars of a category still does not evoke categorical responding. After just two presentations of each of three exemplars, and after four presentations as well, infants responded at the level of the specific exemplars they had seen. They exhibited enhanced attention to a new pose of a novel female face, but not to a new pose of one of the three familiar female faces. There was no evidence that the infants were attending at the level of the category of "female faces" in addition to at the level of the specific exemplars. The infants exhibited enhanced attention to a male face, but no more so than to the novel female face. This failure to differentially respond to the male face and the novel female face may indicate that the infants were in fact not sensitive to the relative familiarity of the novel female face and therefore perceived it and the male test stimulus as equally novel items. It is also possible, though, that the infants did perceive the relative familiarity of the novel female face but that they could not exhibit a differential response to the male face under the circumstances. The response to the male face may have been subject to a ceiling phenomenon--that is, perhaps one can dishabituate to a stimulus only so much and no more, regardless of how discrepant it is.

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Or maybe a potentially vigorous response to the male face was weakened by the fact that it always followed the novel female face, to which the infants also exhibited enhanced attention. The question of whether exposure to limited variation promotes sensitivity to both similarities and differences among stimuli is still an open one. It is clear, though, that such exposure does not eliminate attention to differences.

In conjunction with the results of Studies 1 and 2, the results of Study 3 suggest that categorical responding in the multiple habituation paradigm is primarily a function of the number of different exemplars encountered, rather than of whether each exemplar is encountered often or not. Like the infants shown six exemplars in Study 1, the infants shown three exemplars in Study 3 were offered only two presentations of each. However, whereas the infants shown six exemplars generalized habituation to a novel category member, the infants in Study 3 did not; they exhibited enhanced attention to it. Thus the categorical responding of the infants shown six exemplars was evidently determined by the larger number of exemplars they saw relative to the infants in other conditions. It is possible that the small number of presentations of each exemplar was also important—the responding of infants shown more than three exemplars but shown each one repeatedly could not be assessed, and perhaps it would not be categorical. Nonetheless, encountering more than just a few different exemplars was clearly necessary, if not also sufficient, for the occurrence of categorical responding.

General discussion

The results of Studies 1, 2, and 3 are consistent in indicating that infants' categorical responding is not evoked by exposure to related but nonidentical stimuli in and of itself. Infants shown two and even three

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different exemplars of a category nevertheless responded on the basis of the specific exemplars they had seen, rather than on the basis of the category instantiated. Like infants shown just one exemplar, they dishabituated to a novel category member rather than generalizing habituation to it. Infants shown six different exemplars, however, did generalize habituation to a novel category member and thus responded categorically. Apparently, it is only when the number of variants exceeds some threshold that variegated experience leads infants to ignore differences and respond on the basis of what the different items have in common. This is different from the case with variation and children's word-learning, where the labeling of just two different exemplars of a category directs children to focus on the encompassing category and generalize the term to other unspecified members (Callanan, 1985). It seems that whereas the presence of variation may be genuinely instructional in the word-learning situation, it may operate rather differently with respect to infant categorical responding.

The results reported here also provide information concerning the capacity of visual recognition memory during infancy. Although researchers have begun to define the temporal parameters of infant visual memory, its susceptibility to interference effects, and other factors (see Cohen & Gelber, 1975; Olson & Sherman, 1983; Werner & Perlmutter, 1979), there has been little work on how many items can be retained in memory under various circumstances. The infants in Study 2 provided evidence that they were able to retain at least three items over a brief period of time. The infants in Study 3 exhibited this same capacity even when they had initially seen only two repetitions of each of the three items. Other researchers have reported that infants were able to retain just fewer or

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just more items than the three we noted. Cornell and Bergstrom (1982) found that 7-month-old infants were able to retain only two items in visual memory. They showed infants repetitions of a three-item "list" consisting of photographs of different women's faces. The infants' performance on recognition tests which paired a novel face with one of the three faces on the list indicated that the infants recognized the first and last items on the list but not the middle item. There are any number of differences in procedure which might account for the difference in memory capacity found in our investigation and theirs, but the most likely explanation involves the fact that Cornell and Bergstrom's subjects saw the repetitions of the three familiarization items in a fixed order, while our subjects did not. Thus storage and later retrieval of the items may have been more contextually dependent for their subjects than for ours. Sherman (1983) reported that 18-month-old infants showed recognition memory for the second item in a four-item list of schematic faces. Infants in one study also demonstrated memory for the first item, but those in another failed to show recognition for the first item. Immediate memory for the third and fourth items was presumed, though not assessed. The limited evidence available, then, suggests that the capacity of immediate visual recognition memory for 7- to 18-month-old infants ranges between two and four items, depending on task parameters.

These considerations of memory capacity, along with our findings that infants exposed to six exemplars but not infants exposed to three exemplars evidenced categorical responding, prompt us to speculate that the role of variation in determining categorical responding may have to do with the limitations of visual memory. Perhaps infants focus on the similarities and ignore the differences between a novel category member and habituation

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exemplars precisely when they cannot detect these differences because they do not remember the details involved. Suppose that infants (and adults too) somehow process stimuli at several levels of abstraction. As a series of related stimuli was sequentially processed, the shared aspects which embody the higher levels of abstraction would be repeated, and the memory traces of them presumably strengthened. The details embodying the lower levels of abstraction would not be repeated, however. Memory traces of them would instead proliferate and begin to interfere with one another, and the details would effectively be lost from memory. Only information at levels of abstraction with repeated and therefore relatively few entries would remain to serve as distinct memory "schemas" with which to compare incoming stimuli. According to this notion, the number of specific faces encountered by the infants in Condition III of Study 1 was sufficient to strain their memory capacities, and consequently the representations of the different faces became confused. Although under other circumstances they would certainly be able to discriminate the novel face from any one of the habituation exemplars, following exposure to so many of them, the infants presumably retained no vivid memories for the particulars which distinguished the exemplars from one another and also from the novel face. Their categorical responding may thus have been mistaken or actually "imprecise" recognition.

The suggestion that categorical responding is essentially a failure of memory for details is supported by recent findings that infants (following exposure to multiple exemplars) responded to an "average" prototype which was not in fact seen during habituation as more familiar than a single exemplar which was seen during habituation (Bomba & Siqueland, 1983; Strauss, 1981). What is to be emphasized is that the prototype or summary

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representation in such instances may not really be actively constructed by the infant. Rather, it may be the "vague remnant" left in a limited-capacity memory that has been overloaded with details. Other researchers have acknowledged this reductionist interpretation of categorical responding, and have tried to eliminate it by including control conditions in which infants demonstrated that they can discriminate the exemplars used in the categorization conditions (see, for example, Bomba & Siqueland, 1983). However, as Sherman (1983) has argued, for genuine categorization, the subject must be aware that the items are different under the circumstances in which they are categorized (responded to equivalently). Sherman tried to satisfy this criterion by testing infants for recognition of specific familiarization items at the same time as testing them for categorical responding to a novel category instance. Her results are not definitive, however. In one experiment, infants did prefer an out-of-category item to a novel category instance, but these infants did not also evidence discrimination between a familiarization item and the novel category instance. In a second experiment, infants did discriminate between a familiarization item and a novel category instance, but in that experiment, preference for an out-of-category item vs. a novel category instance was not assessed. Thus, in no one situation did the same infants both discriminate particular within-category items and respond categorically to a new one. The same may be said of the Bomba and Siqueland experiments; though in separate studies infants both discriminated the various exemplars employed and responded to them categorically, they did not do both within the confines of a single procedure. Thus it is possible that at the time categorical responding was exhibited, after exposure to multiple exemplars, the infants may have been

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essentially uncertain regarding which exemplars they had seen before and which just looked like ones they had seen before.

We have argued that categorical responding may be a passive consequence of certain memory functions and constraints, rather than an intentional act of classification. We do not mean to impose this interpretation on all categorizing behaviors by infants, though. Certainly the generalizations in both verbal production and comprehension that older infants exhibit (Rescorla, 1988; Thompson & Chapman, 1977), as well as their sorting behavior (Nelson, 1973; Starkey, 1981) and recognition of what must be considered conceptual categories (Reznick & Kagan, 1983; Ross, 1988), may betoken the deliberate search for and attention to invariants. However, a different mental phenomenon may underlie the sensitivity of young infants to perceptual categories that has been demonstrated with the multiple habituation and multiple familiarization paradigms. In these procedures, variation may not so much direct infants to ignore the differences among stimuli as force them to forget them, by offering exemplars too numerous to keep track of individually. The notion that infants' responses following exposure to multiple exemplars may be due to memory failure in no way detracts from the findings of studies in which these responses have been investigated. The responses are, after all, based on perceived similarity to the "imprecise" schemas which remain after exposure to many exemplars. It is important to know what stimuli infants construe as more or less similar to others, even though they may not be truly categorizing them.

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References

Bomba, P. C. & Siqueland, E. R. (1983). The nature and structure of infant form categories. Journal of Experimental Child Psychology, 35, 294-328.

Callanan, M. A. (1985, April). Object labelling and young children's acquisition of categories. Poster presented at the meeting of the Society for Research in Child Development, Toronto.

Carey, S. (1977). The child as word learner. In M. Halle, J. Bresnan, & G. A. Miller (Eds.), Linguistic theory and psychological reality. Cambridge, MA: MIT Press.

Cohen, L. B. & Caputo, N. (1978, March). Instructing infants to respond to perceptual categories. Paper presented at the meeting of the International Conference on Infant Studies, Providence, RI.

Cohen, L. B. & Gelber, E. R. (1975). Infant visual memory. In L. Cohen and P. Salapatek (Eds.), Infant perception: From sensation to cognition. Vol. 1. New York: Academic Press.

Cohen, L. B. & Strauss, M. S. (1979). Concept acquisition in the human infant. Child Development, 50, 419-424.

Cornell, E. (1974). Infants' discrimination of photographs of faces following redundant presentations. Journal of Experimental Child Psychology, 18, 98-106.

Cornell, E. H. & Bergstrom, L. I. (1982, March). Serial position effects in infants' recognition memory. Paper presented at the meeting of the International Conference on Infant Studies, Austin, TX.

Fagan, J. F. (1976). Infants' recognition of invariant features of faces. Child Development, 47, 627-638.

Fagan, J. F. (1978). Facilitation of infants' recognition memory.

BEST COPY

Child Development, 49, 1866-1875.

Harris, P. L. (1983). Infant cognition. In P. H. Mussen (Ed.), Handbook of child psychology: Vol. 2. Infancy and developmental psychobiology (M. M. Haith & J. J. Campos, volume editors). New York: Wiley.

Nelson, K. (1973). Some evidence for the cognitive primacy of categorization. Merrill-Palmer Quarterly, 19, 21-39.

Nelson, K. (1974). Concept, word, and sentence: Interrelations in acquisition and development. Psychological Review, 81, 267-285.

Olson, G. M., and Sherman, T. (1983). Attention, learning, and memory in infants. In P. H. Mussen (Ed.), Handbook of child psychology: Vol. 2. Infancy and developmental psychobiology (M. M. Haith & J. J. Campos, volume editors). New York: Wiley.

Rescorla, L. A. (1980). Overextension in early language development. Journal of Child Language, 7, 321-335.

Reznick, J. S. & Kagan, J. (1983). Category detection in infancy. In L. Lipsitt & C. K. Rovee-Collier (Eds.), Advances in infancy research (Vol. 2). Norwood, NJ: Ablex.

Rose, S. A., Gottfried, A. W., Melloy-Carminar, P., & Bridger, W. H. (1982). Familiarity and novelty preferences in infant recognition memory: Implications for information processing. Developmental Psychology, 18, 704-713.

Ross, G. S. (1980). Categorization in 1- to 2-year-olds. Developmental Psychology, 16, 391-396.

Ruff, H. A. (1978). Infant recognition of the invariant form of objects. Child Development, 1978, 49, 293-306.

Sherman, T. (1983). Categorization skills in infants. Unpublished

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manuscript, Laboratory of Developmental Psychology, NIMH, Bethesda, MD.

Starkey, D. (1981). The origins of concept formation: Object sorting and object preferences in early infancy. Child Development, 52, 489-497.

Strauss, M. S. (1979). Abstraction of prototypical information by adults and 10-month-old infants. Journal of Experimental Psychology: Human Learning and Memory, 5, 618-632.

Strauss, M. S. (1981, April). Infant memory of prototypical information. Paper presented at the meeting of the Society for Research in Child Development, Boston, MA.

Thompson, J. R., & Chapman, R. S. (1977). Who is "Daddy" revisited: The status of two-year-olds' overextended words in use and comprehension. Journal of Child Language, 4, 359-375.

Werner, J. S. & Perlmutter, M. (1979). Development of visual memory in infants. In H. W. Reese and L. P. Lipsitt (Eds.), Advances in child development and behavior (Vol. 14). New York: Academic Press.

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Footnotes

1. In some investigations involving young infants and very brief familiarization periods, enhanced attention to the familiar test stimulus rather than to the novel one has been observed. However, in the research reported here, the infants were older than those in the studies in which familiarity preferences have been observed, and during familiarization they were shown repeated presentations of the stimuli, each of which furthermore remained available for viewing until the infant looked away. Under these circumstances, enhanced attention to the novel test stimulus, if to anything, would be expected, and hence the use of one-tailed tests was considered appropriate.

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Table 1

Mean log looking times to the last habituation slide before the tests (LH), the familiar test slide (FT), and the novel slide (NT) for each condition and study.

STUDY 1

	Condition I (1 face)			Condition II (2 faces)			Condition III (6 faces)		
Measure	LH	FT	NT	LH	FT	NT	LH	FT	NT
M log looking time	.74	.74	.99	.65	.72	.96	.57	.67	.67
SD	.30	.42	.30	.26	.37	.35	.32	.33	.35
t(20)		-.02	2.79**		1.11	4.31***		1.02	1.03

	Study 2 (3 faces)			Study 3 (3 faces) Block 1			Block 2		
Measure	LH	FT	NT	LH	FT	NT	LH	FT	NT
M log looking time	.68	.68	.87	.79	.78	.95	.63	.76	.91
SD	.44	.45	.43	.34	.32	.26	.32	.28	.42
t[a]		.01	2.28**		-.10	1.77*		1.41	2.06*

Note. t values listed are for correlated, one-tailed t-tests comparing the column of entry (FT or NT) vs. the last habituation slide (LH).

[a] df for study 2 = 20, for Study 3 (Block 1) = 17, and for Study 3 (Block 2) = 14.

*p < .05 **p < .02 ***p < .005

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